IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Keum Joo LEE, et al.

Art Unit: 1746

Serial No. 09/955,126

Examiner: Michail Kornakov

Filed: September 19, 2001

Confirmation No. *8415*

For: METHOD OF CLEANING DAMAGED LAYERS AND POLYMER RESIDUE FROM SEMICONDUCTOR DEVICE

Atty. Docket No. 259/011

Commissioner for Patents
P.O. Box 1450
Alexandria, Va. 22313-1450

DECLARATION UNDER 37 C.F.R. § 1.132
OF:

Keum Joo Lee

Sir:

1. I, Keum Joo Lee, a citizen of the Republic of Korea, having an address of 304-1401, Sinyoungtong Apartment, Whasung-city, Gyunggi-do, Korea, declare and say that:

2. I am co-inventor of the invention which is the subject matter of United States Patent Application Serial No. 09/955,126, filed September 19, 2001, and claiming priority benefit under 35 U.S.C. § 119 to Korean Patent Application No. P2001-76559;

3. I am presently employed by Samsung Electronics Co. Ltd., Seoul, Korea;

4. I am a graduate of Chungang University and received a master's degree in Chemistry in February 1996;

5. I have been an employee of Samsung Electronics Co. Ltd. since 1996 and have been engaged in research and development in the area of semiconductor device fabrication in Samsung Electronics Co.'s Photo-Etch Technology Department. From 1996 to the present, a period of 8 years, I have been researching cleaning processes for DRAM devices;

6. I therefore have over 8 years of experience in the field of technology relating to semiconductor device fabrication, and particularly to cleaning methods therefor, the subject matter of the above-referenced patent application;

7. Because of my own education and experience, I believe myself to be one of at least ordinary skill in the art of semiconductor device fabrication. Based upon my 8 years of semiconductor device fabrication experience, it is my opinion that one of ordinary skill in the art of semiconductor device fabrication would be one with a scientific degree, having at least two years experience in the design and/or fabrication of semiconductor devices;

8. I conducted experiments that led to the presently claimed invention, in which a method of cleaning a semiconductor device in a certain way and with a cleaning solution containing a very specific concentration range of hydrofluoric acid (HF) and for a particular intended result is disclosed and claimed. The intended result is to provide a contact region of a semiconductor device with a decreased resistance without causing a decrease in the breakdown voltage between the contact region and an adjacent conductive layer, which would lead to current leakage at the contact region. The method using the solution having the very specific concentration range of hydrofluoric acid (HF) is claimed in each of the independent claims of the subject application as amended herewith, viz., claims 1, 8, 18 and 29.

9. Exhibit A hereto provides FIG. 2 of the subject application illustrating the important and unexpected results of some of the above-mentioned experiments. FIG. 2 is a graph illustrating a relationship between both resistances of contact regions of semiconductor

devices and breakdown voltages between the contact regions and conductive layers adjacent to the contact regions in the semiconductor devices, respectively, and HF concentrations of cleaning solutions after cleaning the semiconductor devices with the respective cleaning solutions containing the different concentrations of HF. Line D of FIG. 2 represents the resistances of the contact regions of the semiconductor devices, and line C of FIG. 2 represents the breakdown voltages between the contact regions and the adjacent conductive layers of the semiconductor devices, respectively, both of which were obtained after cleaning the semiconductor devices with the solutions including the various concentrations of HF. As illustrated in FIG. 2 and described in paragraph [0028] of the application as filed, line D shows that as the HF concentration of the solution was increased, the resistance of the contact region decreased. A contact resistance of less than 40 KΩ, which is illustrated by a line B in FIG. 2, does not lead to failure of the device. Therefore, because contact resistance is 40KΩ or more for a solution having an HF concentration of about 0.034 wt% or more, the HF concentration of the solution should be above about 0.034 wt%. As illustrated in FIG. 2 and described in paragraph [0029] of the subject application, line C shows that as the HF concentration of the solution was increased, the breakdown voltage between the contact region and the adjacent conductive layer decreased, which results in increased current leakage between the contact region and the adjacent conductive layer. Because a breakdown voltage of 18V or more (18V is illustrated by a line A in FIG. 2) does not result in failure of the device, and because an HF concentration of 0.077 wt% or less results in a breakdown voltage of 18V or more, the HF concentration of the solution should be less than about 0.077 wt%. Therefore, the method of the present invention optimally includes a solution including about 0.034 to about 0.077 wt% HF. The claimed method using the solution including about 0.034 to about 0.077 wt% HF allows a resistance of a contact region to be decreased without decreasing a breakdown voltage between the contact region and an adjacent conductive layer in a semiconductor device.

10. I have carefully read United States Patent No. 5,868,855 to Fukazawa et al. and Japanese Patent No. 07-037851 to Kobayashi;

11. By comparison to my invention, the Fukazawa et al. '855 reference discloses a cleaning solution having a broad HF concentration range of 0.01 to 1 wt% of the total mixture, and

does not disclose or address a problem of resistance of a contact region or breakdown voltage of the contact region and a conductive layer adjacent to the contact region in a semiconductor device, or effects thereto when cleaning a semiconductor device. The broad HF concentration range disclosed by the Fukazawa et al. '855 reference is around 23 times larger than the very specific HF concentration range discovered by my co-inventors and me, which provides the surprising and unexpected results described above and illustrated in FIG. 2. It is not obvious to select from a relatively broad range, as disclosed in Fukazawa et al. '855, a precise and minute range of HF concentration in a solution that provides the benefits taught by the subject application, due to difficulties in the selection process;

12. The Kobayashi '851 reference teaches mixing a solution of HF and pure water uniformly to provide a uniform solution thereof and monitoring the HF concentration of the solution to provide a solution having high homogeneity and high reproducibility so that a device using the solution provides a consistent etching rate. Although the Kobayashi '851 reference emphasizes mixing the solution to provide a uniform solution, the Kobayashi '851 reference neither discloses nor suggests an optimal HF concentration range of the solution, and does not address a problem of a decreasing breakdown voltage between a contact region and an adjacent conductive layer as a result of decreasing a resistance of the contact region, as taught and addressed by the subject application. Accordingly, the Kobayashi '851 reference neither discloses nor suggests a method using a solution including the very specific HF concentration range of the present invention as claimed;

13. Both the Fukazawa et al. '855 reference and the Kobayashi '851 reference fail to disclose providing the treating liquids set forth therein with an HF concentration range that allows a resistance of a contact region of a semiconductor device to be decreased without causing a decrease in a breakdown voltage between the contact region and an adjacent conductive layer. Rather, the field of these references is interested in cleaning a wafer or substrate using hydrofluoric acid per se. Thus, there is no motivation provided in either reference or a combination thereof for using the solution having the very specific HF concentration range as now taught by the present invention;

14. The solutions taught by the Fukazawa et al. '855 reference and the Kobayashi '851 reference would not, under ordinary circumstances, i.e., without undue experimentation and

manipulation thereof, obtain results remotely similar to those obtained by application of my invention as claimed.

15. It is my opinion that a person having the qualifications described in paragraph 7, at least as early as September 19, 2001, would not find the present invention as claimed obvious from the disclosure of the Fukazawa et al. '855 reference.

16. It is my opinion that a person having the qualifications described in paragraph 7, at least as early as September 19, 2001, would not find the present invention as claimed obvious from the disclosure of the Fukazawa et al. '855 reference in view of the disclosure of the Kobayashi '851 reference.

17. The undersigned inventor declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Keum-Joo Lee

Keum Joo Lee

Date: 2.1P.2004

EXHIBIT A

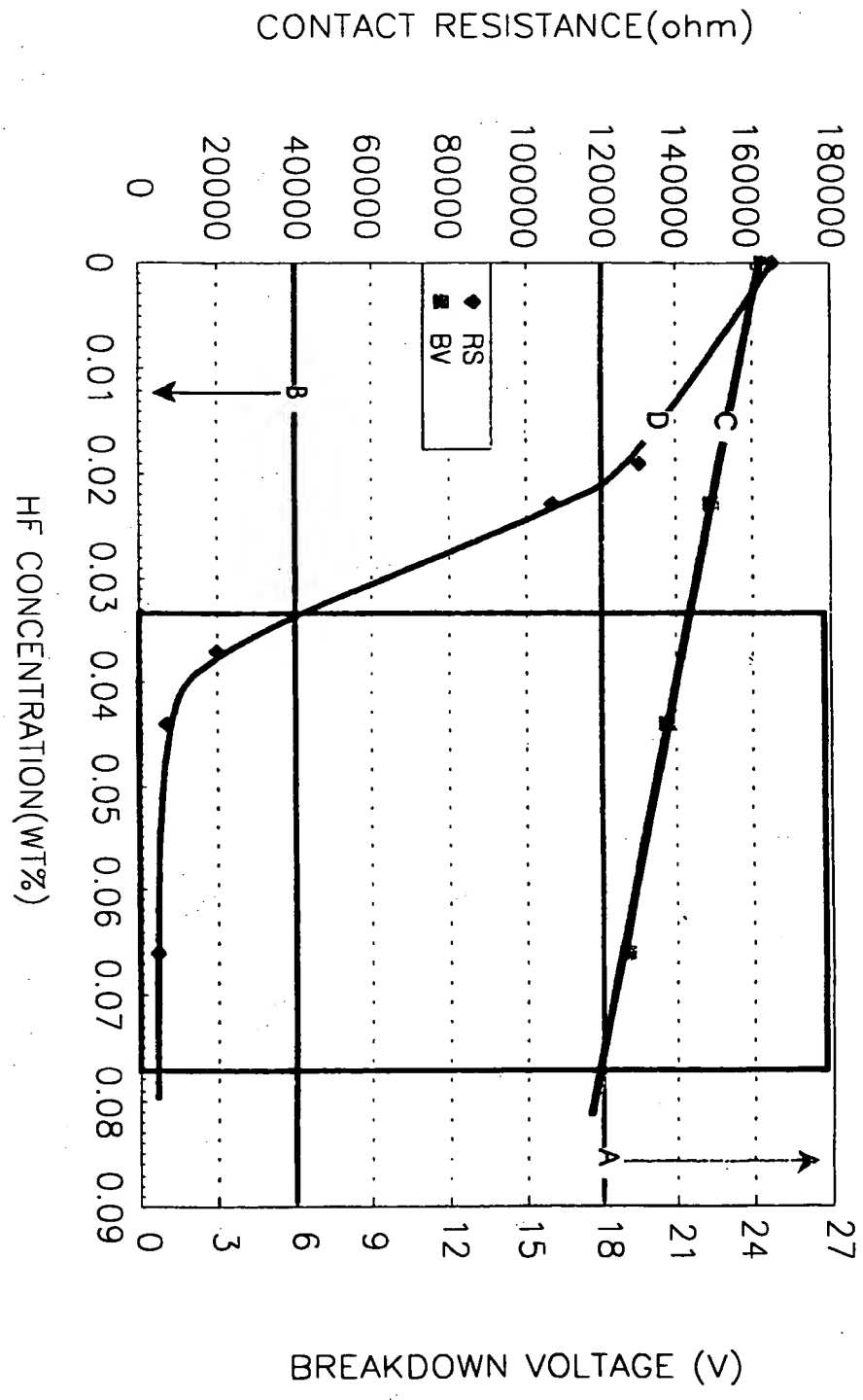

FIG. 2